

STUDIES IN NEARCTIC DESERT SAND DUNE ORTHOPTERA

PART VI

A NEW GENUS AND THREE NEW SPECIES OF LARGE SAND-TREADER CAMEL CRICKETS FROM THE COLORADO DESERT WITH KEYS AND NOTES

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This is another treatise on the Sand Dune Fauna completed under a grant from the National Science Foundation.

For quite some years now, especially during the course of four summers of extensive exploration and intensive study on the sand dune biotae of the North American Deserts and with the accumulation of considerable materials representing well over a dozen new species, it has been increasingly apparent that the sand-treader camel cricket genus *Ammobaenetes* Hubbell 1936, is not a congeneric one.

The genotype of *Ammobaenetes* is *Daihinia phrixocnemoides* Caudell 1907, a small Rhaphidophorid possessing, in the apical half of its straight caudal tibiae, a closely packed group of 5 to 6 pairs of long aciculate spurs forming a "sand basket" by which it jumps and digs readily in loose drifting sand and from which it derives both its scientific and common names. The female has a rather long, straight, slender ovipositor whose length is approximately one-half that of the body length and with which she oviposits rather deeply in the loose sand.

Restricted to, and existing on, the sand dunes of the Colorado Desert and dune areas peripheral to it but pertaining to the Gila Desert, both eremological components of the Great Sonoran Desert, is a group of much larger sand-treaders whose body size is two to three times that of members of true *Ammobaenetes* as based on the genotype. The large males of this group possess strongly arched or bowed caudal tibiae and the ovipositor of the female is very short and heavy, its length about one-sixth body length, or approximately the length of the pronotum. All species of this sand-treader complex have these important features. Their habits and life zones differ from those of the genus *Ammobaenetes* and it is obvious that here, contained in the genus *Ammobaenetes*, is a generic entity quite distinct from that genus. It is the purpose of this paper to describe this generic entity and the various species representing it.

To facilitate the student, a provisional key is here presented.

PROVISIONAL GENERIC KEY TO THE SAND-TREADER
CAMEL CRICKETS AND ALLIES

1. Mesotibiae with 3 to 5 pairs of dorsal spines (sometimes irregularly placed) exclusive of the calcars 3
 Mesotibiae with 2 pairs of dorsal spurs (sometimes only 3) exclusive of the calcars 2
2. Sand basket present and formed by crowding apically of 4 pairs of long acuminate spurs. Ovipositor equal to the pronotal length *Rhachocnemis* Caudell
 Sand basket absent. Ovipositor exceeding the length of the pronotum *Ceuthophilus*, *Pristoceuthophilus*, *Udeopsylla*, *Styracosceles*
3. Sand basket formed of 4 to 6 pairs of long acuminate spurs, somewhat flattened on their inner faces and crowded apically on the caudal tibiae 5
 Sand basket absent 4
4. Caudal tarsomeres—3, their distoventral angles well rounded. Ovipositor 1.5 to 2.0 times their pronotal length . . . *Daihinia* Haldeman
 Caudal tarsomeres—4, their distoventral angles strongly acute. Ovipositor equal to pronotal length *Daihiniodes* Hebard
5. Size small; external inferior keel of caudal femora untoothed or with a few minute teeth. Caudal tibiae straight. Ovipositor long, slender, about one-half body length or twice pronotal length 7
 Size medium to very large; external inferior keel of caudal femora bearing strong teeth. Caudal tibiae straight or strongly arched. Ovipositor short and heavy, its length about the pronotal length 6
6. Size medium to medium large. Caudal tibiae strongly arched in the male, female straight. External inferior keel of caudal femora with row of uniform strong teeth; internal keel also dentate. Tarsomere ratio 3-4-4, the distoventral angles spinose or acute *Macrobaenetes* n. gen.
 Size medium to very large. Caudal tibiae straight in both sexes. External inferior keel of caudal femora with 2 to 4 very large spike-like teeth centrally situated on the keel, preceded and followed by smaller teeth. Tarsomere ratio 3-4-4, the distocentral angles spinose or acute *Daihinibaenetes* Tinkham

7. Tarsomere ratio 3-4-4, their distoventral angles well rounded
 *Daihiniella* Hubbell
- Tarsomere ratio 3-4-3; their distoventral angles spined or acute
 *Ammobaenetes* Hubbell

Macrobaenetes NEW GENUS

The new genus *Macrobaenetes* is amply distinguished from *Ammobaenetes* Hubbell by many characters as: much larger size, the strongly arched or bowed caudal tibiae of the male, the dentition on dorsal ridge and inferior keels of the caudal femora which in *Ammobaenetes* is nondentate; by the tarsomere ratio of 3-4-4 instead of 3-4-3 as in *Ammobaenetes*; by the long first caudal tarsomere which in *Ammobaenetes* is very short; by the short ovipositor being about half the length observed in *Ammobaenetes* in relation to body length and by other minor features as well.

The males of *Macrobaenetes* are distinguished from all other large sand-treaders by the strongly arched caudal tibiae; the female separated from *Daihinibaenetes* Tinkham by the fine teeth on the external inferior keel of the caudal femora and by the same character from *Daihinia* and *Daihiniodes* which do not possess sand baskets, that is, at least 5 pairs of long aciculate spurs, somewhat flattened internally and crowded apically and without any small teeth intervening between these long spurs.

Description: Form typical of the heavier-bodied Rhaphidophorids. Maxillary palpi with all segments slender and elongate, the apical palpomere broadened and recurved in the distal two-thirds, its ventral surface sunken or excavate to leave a sensitized periphery; labial palpi with segments elongate, the apical segment enlarged in distal half. Pronotum with foremargin slightly concavely emarginate; lobes of all thoracic notites with slight narrowly reflexed margins. Leg spination as follows: forefemora unspined dorsally, ventrally unspined except for single tooth on internal keel. Foretibiae unspined dorsally except for small uniform pair of calcars; ventrally with 4 pairs of long tapering spurs plus the apical calcars, the external row much the larger. Foretarsi trimerous, segments 1 and 2 very short, segment 3 twice their combined length; distoventral angles of 1 and 2 lobate, of 3 acute. Middle legs with meso femora unspined dorsally and ventrally except for a tooth on each lower genicular lobe. Mesotibiae dorsally with 3 to 4 pairs spines plus apical calcars; ventrally with 3 pairs smaller spurs,

spaced as dorsally, plus apical calcars. Mesotarsomeres 4, segments 2 and 3 very short, 1 equal to 4 and each twice length of 2 and 3. disto-ventral angles acutely rounded in 1 and 4, acutely lobate in 2 and 3. that of 2 much the largest. Hind legs with semiappressed teeth on the dorsal ridge; external inferior keel with 16 to 18 large heavy teeth and internal inferior keel with 14-16 much smaller ones. Teeth in the female much smaller. Caudal tibiae of male strongly arched; the ventral keel unspined except for median appressed subapical tooth and pair of small attingent calcars; the dorsal keels with 7 evenly paired spurs, 5 pairs of which form the sand basket in the apical quarter plus the long apical calcars which are also part of the sand basket. Caudal tarsomeres—4, segments 2 and 3 very short, segment 4 twice the length of 2 and 3, segment 1 about one and one-third times the length of 4; distoventral angles similar to those of mesotarsus. Genitalia with supranal plate roundly triangular, deflexed; cerci long, acuminate, hirsute; subgenital plate with rather strong forcipate arms. Ovipositor short, its length slightly less than the pronotal length; dorsal valvulae terminating in acute tooth; ventral valvulae bearing 4 uncinate apical hooks.

Genotype: *Macrobaenetes kelsoensis* new genus and new species.

The generic name refers to the large size of these sand treaders which distinguished them from *Ammobaenetes* Hubbell which are of much smaller size, some species being rather minute.

A key to males of this new genus, based on some of the more important taxonomic features, is presented below.

KEY TO THE MALES OF **Macrobaenetes** NEW GENUS

1. Size very large. Caudal femora with basal portion of the lower genicular lobes armed with 2 or 3, rarely 1 tooth; dorsal teeth confined to ridge; usually 16-18, sometimes 15-22 teeth on external inferior keel. Sides of mesonotum nontuberculate. . . . *valgum* (Strohecker)

Size large. Caudal femora with basal portions of lower genicular lobes armed with 1, rarely 2 teeth; dorsal teeth confined or not confined to dorsal ridge; 8-20 teeth on the external inferior keel. Sides of mesonotum tuberculate or nontuberculate 2

2. Dorsal mesotibial spurs—3 pairs. Caudal femora with dorsal teeth confined to ridge; external inferior keel with 14-20, usually 16-18 large closely spaced teeth. Sides of mesonotum nontuberculate *kelsoensis* n. sp.

Dorsal mesotibial spurs—4 to 5 pairs. Caudal femora with dorsal teeth running in oblique rows exteriorly onto upper portion of outer pagina; external inferior keel with 9 to 18 teeth. Sides of mesonotum with dentate tubercles 3

3. Usually five pairs of dorsal mesotibial spurs. Abdominal notites sparsely tuberculate; metanotum sparsely tuberculate. External inferior keel of caudal femora with usually 8-10, sometimes 8-13 large, widely spaced teeth *algodonensis* n. sp.

Usually 4 pairs of dorsal mesotibial spurs. Abdominal notites and metanotum with sides heavily tuberculate. External inferior keels of caudal femora with usually 13-14, sometimes 9 to 18 large, strong, less widely spaced teeth *sierrapintae* n. sp.

Macrobaenetes kelsoensis NEW SPECIES

FIGURE 1

Differs from *valgum* (Strohecker), *algodonensis* n. sp. and *sierrapintae* n. sp. by possessing only 3 pairs of dorsal mesotibial spurs, instead of 4 or four and $\frac{1}{2}$ or 5 pairs; from *algodonesis* n. sp. and *sierrapintae* n. sp. by the lack of dentate tuberculation on the flanks of the mesonotum; by the confinement of the dorsal teeth to the dorsal ridge in the caudal femora and by the greater number of large strong teeth on the external inferior keel of the caudal femora; from *valgum* (Stroh.) by possessing only 1 instead of 2 or 3 teeth at the base of the inferior genicular lobes of the caudal femora. These characters plus others in the spination and spuration of the caudal tibiae offer ample means to the serious student for their separation.

Description of Male: Size medium large, mesonotum with flanks non-tuberculate; metanotum and abdominal notites with flanks with few tubercles. Leg spination as follows: forecoxal vertical keel unispinate; forefemora untoothed dorsally and ventrally except for a single long apical spine on the inner inferior lobe. Foretibiae dorsally unspined except for the apical calcars; ventrally with 4 pairs of spurs on the apical half, the outer 4 the largest, plus a larger pair of calcars. Foretarso-meres—3, segments 1 and 2 very short, 3 twice length of 1 and 2; distoventral angles of 1 and 2 lobate, of 3 normal. Middle legs with meso-coxal keel unspined; mesofemora unspined dorsally and ventrally on the keels with each inferior genicular lobe bearing a single spine. Mesotibiae dorsally with 3 pairs aciculate spurs, 1 pair in basal half, 2 pairs in apical half, plus smaller apical calcars; ventrally with 3 ex-

ternal spines and 2 internal spines plus calcars. Mesotarsomeres—4, segment 1 and 4 equal and each twice the length of 2 and 3 combined which are both very short; distoventral angles of 1 and 4 acute, of 2 produced into a large, acute, spindle-shaped process with segment 3 similarly shaped and smaller and interdigitating with it posteriorly. Hind legs typical. Caudal femora with dorsal teeth small and confined to the ridge; external inferior keel with 17-18 strong widely-spaced teeth plus a basal tooth or spine on the inferior genicular lobe; internal inferior keel with 13-15 very widely spaced much smaller teeth plus basal and apical teeth on the internal inferior genicular lobe. Caudal tibiae ventrally unspined except for the preapical spur plus the apical and almost attingent calcars; dorsally with 7 pairs of spurs plus apical calcars arranged in this fashion: first pair small, aciculate, at about the basal third and preceded by 2 outer and 6 internal small teeth; second pair spurs about the apical two-thirds, preceded by 6-7 external and 6-8 internal larger teeth; third pair preceded by 1-2 external and 2 internal teeth; fourth pair preceded by 0-1 and 0-0 internal teeth; the rest of the sand basket entire; the first 3 pairs of spurs smallest and semi-aciculate, the remainder long and narrowly spatulate for digging and forming the sand basket. Caudal tarsomeres 4, first slightly longer than 4 which is twice the combined length of the very short second and third segments; distoventral angle of 1 acute, 2 large and spindle-shaped as typical in the genus, 3 smaller than 2 and interdigitating with it posteriorly and 4 normal.

Holotype Male: Kelso Dunes, San Bernardino County, California, elev. 2500 feet, April 30, 1960. Ernest A. Tinkham; on bare hard packed sand ridges one-half mile inland from margin. Calliper measurements: body length 19.0; pronotum 4.8; caudal femora 14.1 x 5.8; caudal tibiae 12.3 mms. Holotype in the Tinkham Eremological Collection.

Description of Female: Size medium, slightly smaller than the Holotype, differing from the type in the following features: caudal tibiae straight and variations of spination as follows: forelegs with forefemora similar to Type; foretibiae ventrally with 4 large external and 3 internal smaller spurs plus larger calcars; protarsomere as in Type. Middle legs as in Type. Hind legs: caudal femora much smaller in length and depth with dentition much reduced: dorsal teeth of ridge much reduced in size and numbers and largely confined to a single row on the internal edge; dentition of lower keels greatly reduced, the external inferior keel bearing 11-14 small scattered teeth plus a small basal tooth on the inferior genicular lobe; internal inferior keel with 12-14 minute

and widely scattered teeth plus 1-2 small basal and 1 larger apical tooth on the inferior genicular lobes. Caudal tibiae straight, dentition and spuration less than in Holotype and as follows: external dorsals with 5-6 minute teeth preceding the first spur at the basal third, 9-12 larger variable teeth preceding spur 2 at the apical third, 1-2 similar teeth preceding spur 3 and rest of spurs of sand basket entire; internal dorsals with 7-8 small teeth preceding spur 1 at the basal third, 9 variable larger teeth preceding spur 2 at the apical third, 1 tooth preceding spur 3 and rest of sand basket entire. Caudal tarsomeres as in the Holotype.

Genitalia: Supraanal plate roundly triangular; subgenital plate semi-circular. Ovipositor slightly less than the pronotal length; dorsal valvulae obliquely truncate with its apex armed with an acuminate spine; ventral valvulae with 4 uncinat hooks, the two at the extreme apex much the largest.

Allotype Female: Same data as the type. Calliper measurements: body length 15.4; length to apex of ovipositor 17.8; caudal femora 11.2; caudal tibiae 9.8; ovipositor 3.7 mms.

Paratype Males: 80, same data as the Holotype but collected on the following nights; 1955: June 18, 2 ♂; 1957: June 14, 1 ♂, June 30, 2 ♂; 1958: April 19, 4 ♂, June 10, 1 ♂, July 1, 2 ♂; 1959: May 9, 25 ♂; May 23, 5 ♂; 1960: April 30, 20 ♂, May 10, 8 ♂; 1961: April 15, 10 ♂. Range in measurements: body length 14.5-18.0; pronotum 4.2-4.8; caudal femora 11.8-16.0, caudal tibiae 9.2-13.0 mms. Paratypes to be distributed to the major orthopterological museums.

Paratype Females: 60, same data as the Holotype but collected on the following nights: 1955: June 17, 1 ♀; 1957: June 14, 1 ♀, June 30, 2 ♀; 1958: April 19, 5 ♀, July 1, 1 ♀; 1959: May 9, 2 ♀, May 23, 5 ♀; 1960: April 30, 20 ♀, May 14, 8 ♀; 1961: 15 ♀.

All paratypes similar to their respective Types.

Historical Ecology: Although I led a small group of young entomologists to the Kelso Dunes for the first time on June 25-26, 1954, it was not until my second visit on June 17-18, 1955, that the presence of the giant sand-treader became known. The small sand-treader *Ammobaenetes* n. sp., to be shortly described, is usually quite abundant in the soft sand of the marginal areas where Creosote, Sand Paper weed, Galleta Grass (*Hilaria rigida*) are common but the giant sand-treaders

dwell on the hard packed sand ridges at least half a mile inland from the dune margins. On my third trip July 12-14, 1956, no *Macrobaenetes* had survived to that late date and only 2 *Ammobaenetes* were found. In the summer of 1957, I commenced my first summer of sand dune research under a three-year grant from the National Science Foundation and my dune research was greatly increased thereby. On June 14-16, I collected 25 "Ammos" and on June 30-July 1 took 2 "Ammos" and 3 *Macrobaenetes*. On the sixth trip, Oct. 25-26, a fine drizzling rain, the only rain in 17 Kelso trips, made a strange night on the dunes. At this time the tiny nymphs of both genera were out and their burrows marked by small sand piles were much in evidence next morning on the sunlit dunes. Despite the winter rains of 1958 that brought a nice array of spring flowers out and made the margins of the Kelso Dunes like drifts of snow from the large white petals of the Dune Primrose, sand-treaders were not abundant, indicating that not winter rains but the late summer and early fall rains regulated the abundance of these creatures. Collections were made on April 19-20, 1958, and later on when the heat of late summer had seared the plant life. I took 7 males and no females and 4 "Ammos" the night of June 10. Still later, after midnight the night of July 1, I found 2 "Macros" and 2 "Ammos." Visits were also made on Sept. 22-23 and Oct. 9-10 of that year. In the spring of 1959 I commenced offering my new course "Nature Study of the Desert" for the Extension Department of San Diego State College and began bringing large classes of teachers and laymen to the Kelso Dunes on an overnight study trip. Such large classes greatly augmented my collecting propensities but naturally destroyed the value of comparative collecting by one person. 1959 trips were made on May 9-10, May 23-24, October 17-18; 1960 trips were on April 30-May 1, May 14-15, Oct. 22-23; 1961 trips on April 15-16.

Biology: The ova of *Macrobaenetes kelsoensis* n. sp. is oval elliptical and measures 3.0 x 1.4 mms. in diameter. The exact compliment of ova per female is not known but is in the neighborhood of 50. Where the eggs are laid is not known for certain, but they are probably deposited down in the stygian chambers deep in the damp sand for their chorion walls are thin and subject to desiccation, and the only place providing constant moisture for the ova would be in their chambers. They do not inhabit animal burrows like the much rarer *Ceuthophilus fossor* Hubbell. The advent of the late summer rains in August and September bring out the tiny young and by October these are about the size of a large "match head" although there is naturally some size

range. Their presence on the hard-packed sand ridges, half a mile inland from the loose sand and vegetated margins, is conspicuously indicated by the small mounds of sand that in favorable locations resemble the colonies of certain terrestrial bees. With experience one can distinguish between their mounds and those of scorpions, solpugids and spiders. I have taken some of these small young and by placing in small cartons with sand and feeding daily with a little lettuce have brought them through to maturity about the time those on the Kelso Dunes are maturing. These October nymphs are undoubtedly in their second stadia of their lives, there is another molt in January which brings them to almost half-grown size, and perhaps another molt in March before the final molt in April. The young dig their tunnels rather shallowly because the temperatures are cool during the winter months but the tunnels lengthen with the maturity of their occupants. The adults in May and June dig down at about 35-40 degrees of angulation with the surface and continue in a straight line downwards to pierce deeply in the damp sand layer which is usually down 8 or 9 inches. At the end of their tunnel, often two feet or more in length, they excavate a small chamber hardly bigger than themselves and here they rest during the day with their heads always pointing upwards and outwards. How they know, down in that blackness when evening is approaching is perhaps best explainable in the marvelous time mechanism possessed by wild creatures, but as dusk or darkness approaches, the sand-treaders are usually found at the mouths of their burrows waiting for darkness to encompass the dunes so that they can begin their purposeful perigrinations.

At night their wanderings are almost entirely in search for food which seems to be mainly the seeds of the Dune Grass (*Orzyopsis hymenoides*), bits of organic matter such as dried leaves, perhaps nibbles on green dune grass cut down by Kangaroo rats or other dead protein matter such as bits of dead insects or otherwise. No mating observations have ever been witnessed in nine years of study.

The Kelso Dunes are always damp 6-8 inches down, sometimes only 3-4 inches down, even during the driest years. It is believed the Kelso Dunes have their origin in subterranean or subammean springs emanating from the delta region of the Mohave River some miles to the southwest in what is called the "Devil's Playground" for even the highest Kelso Sand Peak of 700 feet elevation and undoubtedly the highest in the United States, is always wet to the top. This fortuitous circumstance is what creates the remarkable and rather indiginous nature of the biotae of the Kelso Dunes.

Enemies: The only known enemy is the Sand Dune Scorpion (*Paranurctonus mesaensis* Stalınke). I have found complete and partial remains of these sand treaders in the scorpions' chambers down in the sands. Their enemies have enemies, too, for the American Raven purposely hunts for the sites of the scorpion burrows and exhumes the creatures with their long heavy beaks, whack off their lethal extremities and devour their juicy bodies. Scorpions also kill and eat their own kind, the larger preying on the smaller, so that the effect of scorpions on the sand treader population is negligible. The great factor controlling sand-treaders is heat and the advent of the torrid heat of late May and early June soon decimates the sand-treader population. In general the female sand treaders survive longer than the males because their bodies are packed with developing ova.

This interesting new species of the new genus *Macrobaenetes* which is restricted to aeolian sand dunes of the Colorado Desert and its peripheral area, is named after that magnificent pile of quartz sand, whose high peak of 700 feet is unquestionably the highest in the United States.

Orthopteran associates: The Kelso Dune fauna is considerable. Nocturnal associates are the new *Ammobaenetes*, the large camel cricket *Ceuthophilus fossor* Hubbell and a new Jerusalem cricket that may represent a new genus as well as the following Decticids in good years (i.e. considerable winter precipitation), the large grey, black-winged *Capnobotes fuliginosis*, the very rare *Anoplodusa arizonensis*, and a new species of *Eremopedes*. Diurnal associates are mostly acridids such as *Coniana snowi* on the sands, *Xeracris minimus* in clumps of *Petalonyx Thurberi*, *Ligurotettix coquillettii* on the stems of Creosote, *Trimerotropis p. pallidipennis* an ubiquitous desert species as well as the mantids *Litaneutria minor* and *Stagmomantis*. Sand roaches of undetermined species are also found on the dunes at night; these are being studied by Drs. Gurney and Friauf.

Macrobaenetes valgum (STROHECKER)

FIGURE 3

Dailhiniodes valgum Strohecker, 1960: 31-32, fig. 1.

Strohecker's decision to refer the present genus to *Dailhiniodes* "largely on the basis of its tarsomeres" and not on the sum total of its characters as should be done for more accurate placement, has resulted in placing this creature in a genus that does not possess a "sand basket." Thus, in choosing a single character, he has not only ignored a character of great taxonomic importance, the "sand basket," but by so doing

has ignored zoogeographical concepts as well. In 1936, Hubbell defined the faunistics of his new genus *Daihiniodes* as dwelling "on high plains and eastern foothills of Rocky Mountains in Colorado, to southwestern Texas and Arizona" and I might add, as was also known to Strohecker, as living in the wet, cool, hard gypsum sand substrata of the White Sands. It is hardly conceivable or possible that a creature dwelling in such an environment and at a considerable elevation as defined above, could exist on the torrid sands of the Colorado Desert at elevations little above or even below that of sea level.

Macrobaenetes valgum (Strohecker) differs from *kelsoensis* n. sp., *algondonensis*, n. sp. and *sierrapintae* n. sp. by possessing usually 2 or 3 instead of 1 basal tooth on the inferior genicular lobes of the caudal femora. From *kelsoensis* n. sp. it is further separated by its large size and the dentition and spuration of the caudal femora and caudal tibiae; from *algondonensis* n. sp. and *sierrapintea* n. sp. by lacking tuberculation on the flanks of the mesonotum and by the greater number of teeth on the external inferior keel of the caudal femora and by the confinement of the dorsal teeth to the ridge in the caudal femora.

Description of Male: Size very large and typical. Mesonotum usually smooth, metanotum and first five abdominal notites weakly tuberculate, the tubercles confined to a sparse row on the flanks just cephalad of the posterior margin. Forelegs with forecoxal vertical keel unispinate; forefemora dorsally and ventrally unspined except for a slender spine on the internal inferior genicular lobe; foretibiae dorsally unspined except for the calcars, ventrally with 4 pairs of spurs, outer row the largest, on the apical two-thirds, plus a pair of larger calcars. Protarsomeres—3, segments 1 and 2 very short, segment 3 twice combined length of 1 and 2; distoventral angles of 1 and 2 acutely lobate, of 3 acute. Middle legs; mesocoxal ridge unspined; mesofemora dorsally unspined, ventrally with a small spine arising from each of the inferior genicular lobes; mesotibiae with 4, sometimes 3 or 3 and $\frac{1}{2}$, dorsal pairs of spurs plus large calcars, ventrally with 3 external and 2 internal spurs plus larger calcars. Mesotarsomeres—4, segments 1 and 4 equal and each twice the combined length of the very short second and third segments, segment 2 large and acutely spindle-shaped with the smaller segment 3 interdigitating posteriorly with it; distoventral angle of 1 and 4 acute, of 2 and 3 acutely lobate. Hind legs: caudal femora with dorsal teeth confined to ridge; external inferior keel with usually 16-18, sometimes 15-22, large strong, uniform, mostly evenly spaced teeth; internal inferior keel with 12-17 much smaller, much

more widely spaced teeth; both lower genicular lobes with 2 or 3 basal teeth or spines. Caudal tibiae typically arched with 7 large or very large pairs of spurs plus an apical pair of very large calcars located as follows: first pair smallest, acuminate, located about the basal third and preceded by 2-7 external and 5-8 internal small teeth; second pair of spurs about the apical two-thirds, slightly larger in size and preceded by 5-6 external and 7-8 internal larger teeth; 3rd pair larger still and preceded by 1-3 external, 1 internal teeth; rest of sand basket entire. Subgenital plate with forcipate arms.

Males. 100. collected as follows: 4 miles west of Indio: 1952: 10 ♂, April 26; 1955: 4 ♂, April 10, 5 ♂, April 26, 3 ♂, May 9; 1957: 10 ♂, May 18; 1958: 1 ♂ nymph, Feb. 21, 11 ♂, April 12, 5 ♂, May 3, ♂, 3 miles west of 1000 Palms: 1958: 8 ♂, May 3; 1959: 3 ♂, May 5, 4 ♂, May 16, 2 ♂, May 19, 1 ♂, May 21; 1960: 18 ♂, April. Palm Springs Depot: 1952: 12 ♂, May 1. All collected by E. R. Tinkham.

Description Female: Size medium large but smaller than the larger male. Form typical for *Macrobaenetes* females and characterized chiefly by leg spination as follows: Forelegs with vertical procoxal keel unispinate; forefemora unarmed dorsally and ventrally with a spine emanating centrally from the internal inferior genicular lobe; foretibiae dorsally unspined with apical calcars; ventrally with 3 internal, 4 external acuminate spurs in apical half plus pair of larger calcars, the external spurs much the largest and forming the tines of a fossorial basket. Protarsomeres—3, the first two segments very short, segment 3 twice their combined length; distoventral angle of segments 1 and 2 acutely lobate, of 3 normal, the segment bristling with short golden hairs. Middle legs with mesofemora dorsally unarmed and ventrally both keels unarmed but with both lower genicular lobes unispinate with a central tooth. Mesotibiae dorsally with 3 and $1\frac{1}{2}$ to 4 pairs of acuminate spurs, 1 and $1\frac{1}{2}$ to 2 in basal half, 2 pairs apical half plus terminal calcars; ventrally with 2 pairs spurs at middle and apical third plus terminal calcars. Mesotarsomeres—4, the first and fourth segments equal and each twice combined length of the very short second and third; distoventral angles of 1 acute, of 2 and 3 acutely lobate of which 2 is larger, of 4 almost normal. Hind leg with caudal femora with dorsal teeth of ridge minute and very sparse and chiefly indicated as a row on the inner edge; external inferior keel with 12-14 minute widely scattered teeth with 1-2 variable small to very small basal teeth on the inferior genicular lobe; internal inferior keel with 8-10 similar teeth

in basal half and with basal and apical tooth on the inferior genicular lobe. Caudal tibiae with 7 pairs of dorsal spines plus apical calcars, the first two pairs smaller and aciculate, the remainder larger and narrowly spathulate and arranged as follows: first pair at the basal quarter and preceded by 4-5 external and 6 internal minute teeth; 2nd pair just distad of center and preceded by 7-8 external and 4-5 internal larger teeth, 3rd pair about the apical third and preceded by 2 external and 1-2 internal and similar teeth; rest of sand basket entire and closely arranged to form the tines of the sand basket. Metatarsomeres—4, first segment larger than 4th which is twice the combined length of the very short 2 and 3 segments; their distoventral angles as in the mesotarsomeres. Ovipositor shorter than the pronotum, very obliquely truncate with terminal tooth; ventral valvulae with 4 teeth, the 2 apical unciniate, the 2 basal mere serrations.

Hypoallotype Female: 3 miles west of 1000 Palms, April 14, 1960, Ernest A. Tinkham; on the wind-swept drift sand in sand dune valley. Measurements: body length 19.8; length to apex of ovipositor 22.8; caudal femur 12.4; caudal tibia 10.0; ovipositor 4.2 mms. Hypoallotype in the Tinkham Collection. A Hypoallotype is one described by a person other than the describer of the species.

Hypoparatypes: 149, with following data: 4 miles west of Indio: 1952: 12 ♀ April 26; 1955: 5 ♀ April 10, 3 ♀ April 26, 3 ♀ May 9; 1957: 13 ♀ May 18; 1958: 2 ♀ nymphs Feb. 21, 12 ♀ April 12, 1 ♀ May 3. 3 miles west 1000 Palms: 1958: 10 ♀ May 3; 1959: 6 ♀ May 5, 7 ♀ May 16, 5 ♀ May 19, 5 ♀ May 21; 1960: 20 ♀ April 14. 1 mile N. Palm Desert: 1959: 15 ♀ May 21. Palm Desert Depot: 1952: 10 ♀ May 1. All collected by E. R. Tinkham. 3 miles W. 1000 Palms. 20 ♀ April 14, 1960, Jacques Helfer.

Hypoparatypes similar to the Hypoallotype. Range in measurements: body length 14.3-21.9; pronotum 3.5-5.0; caudal femora 11.0-13.8; caudal tibiae 8.8-10.8; ovipositor 4.4-4.0 mms. Hypoparatypes to be distributed to various museums.

Distribution: *M. valgum* is found from the sand dunes just south of the Palm Springs Depot, 9 miles west of Palm Springs, California, east along the wind swept sand dune ridges to 2 miles west of Indio. The species apparently does not cross south of Highway 111, nor does it extend as far east as where the Dillon Road joins Highway 66.

Ecology: This species is largely regulated in its abundance by the winter rains which regulate the spring flowers of Coachella Valley. There

are some spots favorable to permanent habitation where springs keep the sands damp, but in very dry years the species disappears over most of the sand areas.

Biology: No observations are available for the early stages in the fall. The Feb. 21, 1958, collection record is the earliest and indicates the species is more than half matured at this time. Temperature readings at this time were at 9:25 P.M. with the sand damp from a recent rain as follows: sand surface 57° and air temperature 62° Fahrenheit. On May 3, 1958, at 3 miles west of 1000 Palms many burrows were noted. These went shallowly under the sand surface at about 2 inches depth and parallel to the surface for about one foot then angled downward at about 40° to terminate in the damp sand substratum. Here the female was found resting facing outwards and upwards. On this date many males were found lying dead on the sands, due to lack of food, and although females were fairly common at this date, males were rare. The Sand Dune Scorpion sometimes prey on these sand treaders.

Orthopteran Associates: Nocturnal orthopteran associates include the rare camel cricket, *Ceuthophilus fossor*, the much rarer *Stenopelmatus fuscus* found in wet springs around Cathedral City and the common sand roaches which are being studied by Drs. Friauf and Gurney. Diurnal associates include *Coniana snowi* on the plant *Coldenia plicata*, *Xeracris minimus* on *Petalonyx thurberi*, *Ligurotettix coquillettii* on Creosote stems, the common *Trimerotropis p. pallidipennis*, *Cibolacris parviceps aridus* and *Derotmema delicatula*, the latter rare.

Macrobænetes algodonensis NEW SPECIES

FIGURE 4

M. algodonensis n. sp. is differentiated from *kelsoensis* n. sp. by possessing 5 instead of 3 pairs of dorsal mesotibial spurs, by the extension exterioradly of the dorsal teeth on the ridge of the caudal femora and by fewer teeth, quite widely spaced, on the external inferior keel of the caudal femora; from *valgum* (Strohecker) by possessing 1 instead of 2 or 3 teeth on the basal portions of the lower genicular lobe of the caudal femora, the fewer teeth on the external inferior keel of the caudal femora and by 5 instead of 3 or 4 pairs of dorsal mesotibial spurs; from *sierrapintae* n. sp. by the weaker tuberculation on the flanks of the metanotum and first five abdominal notites and by fewer and more widely spaced teeth on the external inferior keel of the caudal femora.

Description of Male: Size medium large, form typical. Flanks of the mesonotum bare, metanotum with less than 10 dentate tubercles, first four abdominal notites with a few tubercles in a single row posteriorly. Leg spination as follows: Forelegs with vertical keel of forecoxae unispinate; forefemora unspined dorsally and ventrally with the inferior genicular lobes each bearing a single spine or tooth, the internal one the larger; foretibiae unspined dorsally plus the apical calcars, ventrally with 3 pairs of spurs in the apical half plus the calcars. Protarsomeres—3, first 2 segments very short, third about 2 and $\frac{1}{2}$ times 1 and 2; distoventral angles of 1 and 2 lobate, of 3 normal. Middle legs; mesocoxae unspined; mesofemora unspined dorsally, ventrally as in the profemora with an additional small tooth on the apical external keel; mesotibiae dorsally with 5 pairs of long aciculate spurs plus similar calcars, ventrally 2 pairs of spurs, one median, one apical plus apical calcars. Mesotarsomeres—4, first slightly longer than the fourth, the fourth about twice the combined length of the very short 2 and 3 segments; distoventral angles somewhat acute in 1 and 4, greatly produced in 2 and smaller in 3 which interdigitates posteriorly with it. Hind legs typical; caudal femora with dorsal teeth mostly confined to the dorsal ridge, some extending exterioradly in oblique rows onto the upper edge of the outer pagina; external inferior keel with 9-10 mostly large, widely spaced teeth plus a large tooth on the basal portion of the lower genicular lobe; internal inferior keel with 6-11 very widely spaced, minute teeth plus a basal tooth on the inferior genicular lobe. Caudal tibiae with 8 pairs of spurs including the calcars of which the five apical pair plus the calcars are very long and narrowly spatulate to form the sand basket, the remaining three pairs aciculate and arranged in this fashion: first pair small at the basal third preceded by 7 small teeth on each keel, 2nd pair at the apical two-thirds and preceded by 12-13 external and 8-10 internal similar teeth, third pair and first pair of the "sand basket" preceded by 1-2 external and 2-3 internal teeth, fourth pair preceded by 1 external and 1 internal tooth, rest of the sand basket without teeth between them.

Holotype Male: Algodones Dunes, 15 miles NW of Yuma in California and $\frac{1}{4}$ mi. E bridge on All American Canal, Apr. 25, 1958. Ernest R. Tinkham. Calliper Measurements: body length 11.8; pronotum 3.9; caudal femora 14.9; caudal tibiae 12.2 mms. for dried alcoholic material. Type in the Tinkham Eremological Collection.

Description of Female: Size similar to Holotype from which it differs chiefly in spination of legs and genitalia. Forelegs with forefemora un-

spined dorsally and ventrally with the internal inferior genicular bearing an apical spine, remainder as in Holotype. Middle legs as in Holotype. Hind legs with caudal femora shorter and less deep than in Holotype, the dentition much reduced and as follows: dorsal teeth on ridge of caudal femora minute and largely confined to a row on the internal edge; external inferior keel with 4 medium-sized teeth widely separated on the middle portions of the keel plus a basal tooth on the lower genicular lobe; internal inferior keel unarmed with basal and apical small teeth on the lower genicular lobe. Caudal tibiae dorsally with 8 pairs of spurs characterized as follows: externally first spur at basal quarter preceded by 6 small teeth, second spur just distad of center and preceded by 10-11 larger teeth; third spur just distad of the apical third and preceded by 1-2 similar teeth; rest of spurs entire and forming the outer tines of the sand basket; internal dorsal keel with first spur at basal quarter preceded by 9-10 small teeth, second spur situated in the middle and preceded by 6-7 larger teeth, spur three at about apical third and preceded by 4 similar teeth and rest of sand basket entire. Caudal tarsomeres as in Holotype. Ovipositor typical of the genus, shorter than the pronotum; the dorsal valvulae obliquely truncate and terminating in a spine; ventral valvulae with 4 apical uncinat hooks, the two at extreme tip conspicuous, the two basal minute.

Allotype Female: Same data as the Holotype. Calliper measurements: body length 14.3; pronotum 3.9; caudal femora 11.0; caudal tibiae 9.8; ovipositor 2.7. Allotype in the Tinkham Collection.

Paratype Males: 115 with data as follows: 19. April 28, 1952, same location as Holotype; 13. April 25, 1958, same location as Holotype; 62, April 29, 1961, 2 miles west of Glamis, Calif.; 10. May 13, 1961, same location; 8. 4 miles west Glamis, April 29, 1961; 3, June 5, 1960, 4 mis. W. Ogilby, Calif., Roth and Irwin. Range in measurement as follows for series: 1952 series, body length 11.2-15.9; pronotum 3.0-4.2; caudal femora 10.7-15.0; caudal tibiae 8.8-13.5 mms. 2 miles W. Glamis series: body length 10.0-15.3; pronotum 3.0-3.9; caudal femora 10.6-13.2; caudal tibiae 8.9-11.2 mms. 4 mis. W. Glamis series: body length 16.5-19.2; pronotum 4.2-4.6; caudal femora 14.6-17.0; caudal tibiae 12.5-14.5 mms. Ogilby series: body length 10.5-13.4; pronotum 2.7-3.0; caudal femora 11.0-10.9; caudal tibiae 9.1-9.2 mms.

Paratypes closely similar to the Holotype with slight variation in the dentition of the caudal tibiae but within the species range.

Paratype Females: 140 with data as follows: 9, April 28, 1952, same data as Allotype; 10, April 25, 1958, same location as Allotype; 54, April 29, 1961, 2 mis. W. Glamis; 41, May 13, 1961, 2 mis. W. Glamis; 26, 4 mis. W. Ogilby, June 5, 1960, Roth and Irwin. Range in measurements for series as follows: 1952 series: body length, 13.2-22.8; pronotum 3.2-4.2; caudal femora 9.2-13.0; caudal tibiae 7.8-10.0; ovipositor 2.4-4.1 mms. 2 mis. W. Glamis series: body length 11.0-15.0; pronotum 3.4-3.5; caudal femora 10.7-11.2; caudal tibiae 8.8-9.0; ovipositor 2.8-2.6 mms. Ogilby series: body length 12.8-17.0; pronotum 3.1-3.8; caudal femora 9.7-11.2; caudal tibiae 7.4-9.3; ovipositor 2.2-3.8 mms.

Female Paratypes, closely similar to the Allotype but with considerable size variation depending upon the aridity of the season.

Male and Female Paratypes to be deposited in the major museums and the Tinkham Collection.

Ecology: The dune fauna in recent years with little precipitation is much less than in such springs as 1953, when on the night of April 28, the cold dunes, wet with a late evening cold rain, were covered with dune creatures such as sand treaders, scorpions, solpugids, tenebrionid beetles of several genera and species as well as geckos, all in considerable profusion and immobile on the cold sands. Never before or since have I witnessed such an array of life.

The 1958 and 1960, and 1961 series of sand-treaders average much smaller than the 1953 series. It was interesting in 1961 to find sand-treaders at 4 miles west of Glamis (on the west edge of the dunes) to be much larger than those 2 miles west of Glamis along the main ridge of the Algodones.

Biology: Very little is known specifically about the life history of this new species but generally its life history is similar to that of *M. kelsoensis* n. sp. and the other species. Some adults persist through until mid-June, rarely to late June.

Orthopteran Associates: Nocturnal associates include sand roaches, being studied and the large camel cricket *Ceuthophilus fessor*; diurnal orthopteran associates include such acridids as *Xeracris minimus*, *Coniana snowi* and the everpresent *Trimerotropis p. pallidipennis*.

Macrobænetes sierrapintae NEW SPECIES

FIGURE 2

Differs from *kelsoensis* n. sp. and *valgum* (Strohecker) by the heavy tuberculation on the sides of the meso-, metanotum and first five ab-

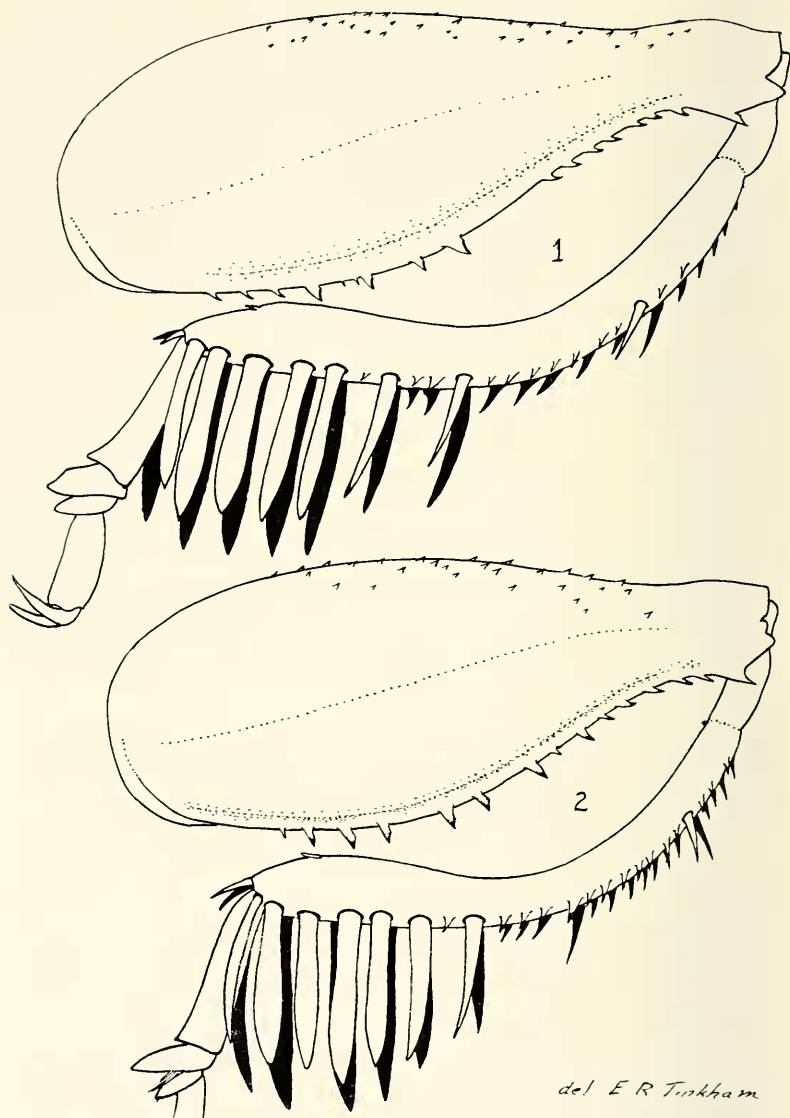


Figure 1. *Macrobaenetes kelsoensis* n. g. et n. sp. Left hind leg of Holotype. Kelso Dunes, San Bernardino County, California.

Figure 2. *Macrobaenetes sierrapintae* n. sp. Left hind leg of Holotype. Sierra Pinta Dunes. 65 miles south of Mexicali, Baja California, Mexico.

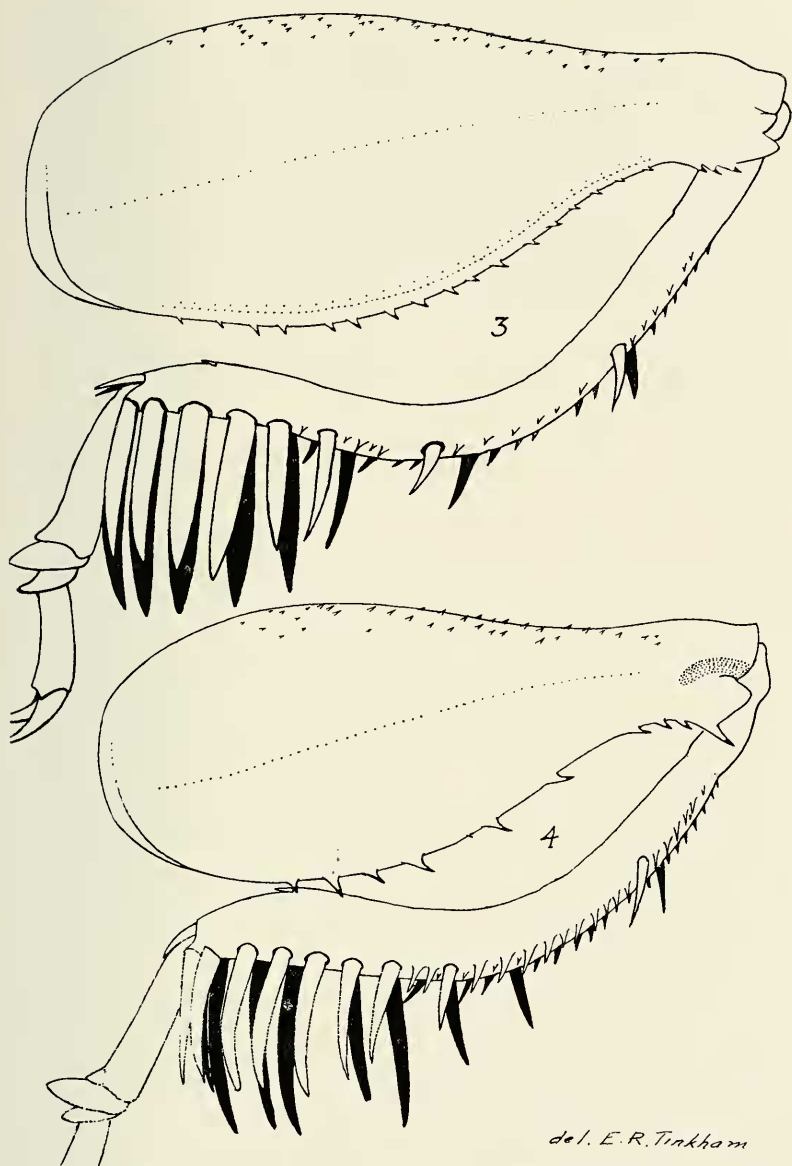


Figure 3. *Macrobaenetes valgum* (Strohecker). Left hind leg of male from dunes 3 miles west of 1000 Palms, Coachella Valley, Riverside County, California.

Figure 4. *Macrobaenetes algodonensis* n. sp. Left hind leg of Holotype Male. Algodones Dunes, 15 miles NW of Yuma, Imperial County, California.

dominal notites; by the larger dorsal teeth of the caudal femora extending obliquely in rows onto the upper portions of the outer pagina; by the dentition on the external inferior keel of the caudal femora and the spination and dentition on the caudal tibiae. From *kelsoensis* it is further distinguished by possessing 4 or more pairs, instead of three, dorsal mesotibial spurs and from *valgus* by having only one instead of two or three teeth on the basal portions of both external and internal lower genicular lobes of the caudal femora. From *algodonensis* n. sp. it is separated by the greater dentition on the external inferior keel of the caudal femora; the dentition and spuration of the caudal tibiae as well as by the heavy tuberculation on the flanks of the metanotum and first five abdominal notites which in *algodonensis* is sparse.

Description of Male: Size large, flanks of pronotum bare, mesonotum posteriorly with few scattered tubercles; metanotum and first five abdominal notites heavily dentate tuberculate. Leg spination as follows: Forelegs with vertical procoxal ridge unispinate; profemora unispined dorsally and ventrally with both lower genicular lobes unispinate, the internal one larger. Protibiae dorsally with 2 internal, 1 external spur basally plus apical calcars; ventrally with 3 pairs of aciculate spurs in apical half plus a pair of larger similar calcars. Protarsomeres—3, first 2 segments very short, the third twice the combined length of 1 and 2; distoventral angles of 1 and 2 lobate, of three normal. Middle legs with mesocoxal ridge unispined; mesofemora as in the profemora. Mesotibiae dorsally with 4 and $\frac{1}{2}$ pairs of aciculate spurs, 2 pair basal half, 2 pair apical half and one intermediate spur on the external keel; ventrally as in the protibiae. Mesotarsomeres—4, first and 4th segments about equal and each twice the combined length of the very short second and third segments; distoventral angle of 1 lobate, of 2 produced into a long acute spindle-shaped process with segment 3 similar but smaller and interdigitating with it posteriorly, and segment 4 normal. Hind legs with caudal femora very deep, the external inferior keel gently arcuate; dorsal ridge bearing obliquely running rows of short semi-appressed teeth extending exteriorly onto the upper portions of the face of the outer pagina especially in the apical third; inferior genicular lobes each with a basal tooth, the inner lobe also with an apical tooth; external inferior keels with 13 to 14 mostly large, strong, well spaced teeth; internal inferior keel with 12-13 much scattered and much reduced teeth. Caudal tibiae strongly arched with 8 external and 8 internal dorsal spurs of which 6 pairs in the apical region are long, narrowly spathulate spurs and form the sand basket, the rest are

smaller and more aciculate, the basal 2 pairs located as follows: first pair about the basal third and preceded by 4-5 external and 4-7 internal small teeth; second pair about the $\frac{2}{3}$ rds position and preceded by 7-9 external and 5-7 internal larger teeth; the third pair of spurs preceded by 3 external and 2-3 internal similar teeth; pair 4 by 0-1 external and 1-0 internal teeth, the remainder of the sand basket entire. Caudotarsomeres—4, segment 1 longest and longer than the first mesotarsomere, segments 2 and 3 very short, segment 4 about twice the combined length of 2 and 3; lobation of the distoventral angle as described in the mesotarsomeres.

Holotype Male: Sierra Pinta Dunes, 65 miles south of Mexicali on Highway No. 5, Baja California, Mexico, April 3, 1958, Ernest R. Tinkham. Calliper measurements: body length 14.8; pronotum 4.4; caudal femur 15.0 x 5.8; caudal tibiae 12.1 mms. Holotype in the Tinkham Eremological Collection.

Description of Female: Closely similar in size to Holotype but differing chiefly in dentition of hind legs and genitalia. Leg spination as follows: Fore and middle legs as in Holotype. Hind legs with caudal femora less massive and caudal tibiae straight. Caudal femora with minute dorsal teeth and largely confined to a row on the internal keel; external keel with 14-15 minute teeth plus a larger basal tooth on the inferior genicular lobe; internal inferior keel unarmed, the lower genicular lobe with 1-2 basal and 1 apical larger teeth. Caudal tibiae with only 7 well-arranged pairs of spurs plus apical calcars, the external dorsal keel with the basal pair situated at the basal quarter and preceded by 5-6 small teeth, spur 2 just basad of the apical third and preceded by 10-11 larger teeth, spur 3 at the apical quarter and preceded by 1 tooth, the rest of the sand basket spurs entire or lacking teeth between them; internal dorsal keel with all spurs opposite and matching those on the external keel, spur 1 preceded by 6 small teeth, spur 2 preceded by 10-12 larger teeth, spur 3 preceded by 1 similar tooth and rest of sand basket entire. Caudal tarsomeres as in Holotype. Ovipositor shorter than the pronotum, the dorsal valvulae squarely and obliquely truncate with terminal spine; ventral valvulae with 5 teeth of which the 2 apical are uncinate, the median small and the two basal mere serrations.

Allotype Female: Same data as the Holotype. Measurements as follows: body length 13.8; length to tip ovipositor 16.8; pronotum 4.7; caudal femur 13.3 x 4.5; caudal tibia 11.6; ovipositor 4.0 mms. Allotype in the Tinkham Collection.

Paratype Males: 82, same location as Holotype but collected as follows: 10 ♂, April 11, 1953; 29 ♂, April 3, 1958; 18 ♂, May 13, 1961, all E. R. Tinkham. 25 ♂, April 15, 1960. Pearson, San Diego State College. Paratypes closely similar to the Holotype with slight deviation in dentition of caudal tibia falling within the species range.

Paratype Females: 104; same locality as Holotype but collected as follows: 31 ♀, April 11, 1953; 26 ♀, April 3, 1958; 22 ♀, May 13, 1961, all E. R. Tinkham. 25 ♀, April 15, 1960 (Pearson; Michigan Cln).

Paratypes closely similar to Allotype.

Paratypes to be deposited in the major Museums and Tinkham Cln.

Ecology: With no meteorological stations or records available from northeastern Baja California, it is difficult to determine good or bad years as far as precipitation is concerned, but usually the west coastal plain of the Gulf of California is exceedingly dry and drier than even the Californian portion of the Colorado Desert. In 1953, the species was fairly common in the swales lying between the bare sand ridges, these swales being flat bottomed and containing semistabilized hummocks of *Atriplex polycarpa* and Creosote (*Larrea divaricata*). On April 3, 1958, in the same swale I counted 25 specimens around one large hummock of approximately 10 x 15 feet dimensions. In 1961, the sand ridges bordering this swale had grown considerably in height but the swale bottom was unchanged. Despite a winter with practically no precipitation in the northern Californian portion of the Colorado Desert, *Macrobaenetes sierrapintae* was not rare, although there were rumors of a fall storm in 1960 crossing the area but not verified.

Biology: Nothing in particular is known about the more intimate life history of this species. The sands are much drier than the Algodones or Kelso Dunes and yet this distinct and attractive species survives under much more xeric conditions.

Orthopteran Associates: These are very few. The only other nocturnal orthopteran is a large species of *Ceuthophilus* of the *fossor* group and sand roaches which are being studied by Dr. Gurney and Dr. Friauf. The only diurnal orthopteran is the acridid *Anconia integra* which feeds on *Atriplex*.

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